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LAND DEVELOPMENT

A Guide To Clearing, Piling, Breaking and Working Down Land in Northwestern Alberta

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LAND DEVELOPMENT:

A GUIDE TO
CLEARING, PILING, BREAKING AND WORKING DOWN LAND
IN NORTHWESTERN ALBERTA

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PREFACE

The purpose of this report is to describe land development methods used in northwestern Alberta, and make recommendations that may help others avoid the same pitfalls we have experienced.

Our information was obtained through working over the last 13 years in the Grazing Reserve Development Program, as well as from personal experience in farming and land clearing. We have also benefited from the many farmers and contractors who have shared their experience with us over the years.

This report describes the machinery and results expected, but avoids specific recommendations since operator competence and correct timing of work may have as much influence on the finished product as the type of machinery.

INTRODUCTION

Clearing woody cover for agricultural use is an ancient practice. Traditional land clearing was a tedious, back-breaking process. With the advent of the crawler tractor, mechanized clearing became an effective, economical reality. Specialized equipment evolved to handle all stages of land development.

Land development is a costly and time-consuming process. Done properly, each operation on the land is part of a prescribed sequence that facilitates the next step in development. This report can help you select the land development methods and machinery most appropriate to your situation.

1.0 CLEARING

The goal in land clearing is to remove all above-ground woody vegetation in the best way to facilitate later operations (i.e., breaking, working down, seeding, etc.).

The two main methods of brush clearing are cutting and walking down; all clearing methods are variations of these two systems. Factors to consider when choosing a method are:

- soils (type, texture, rockiness, etc.)
- vegetation (size, density, species)
- topography
- time of year
- intended use of land (i.e., pasture, farmland, reforestation)
- location
- costs
- availability of machinery and labour
- weather

These factors, together with the method of clearing, will affect the rate and quality of work as well as influence the machinery and methods that can be used in later stages.

1.1 Cutting Brush

1.1.1 Cutters

To cut brush, a tractor with a cutting attachment severs the tree at ground level, leaving root growth intact in the ground. These attachments may be of the push blade type (sidecutters and V-cutters) or rotary cutter types which include pull, boom and self-propelled cutters.

1.1.1.1 Sidecutter

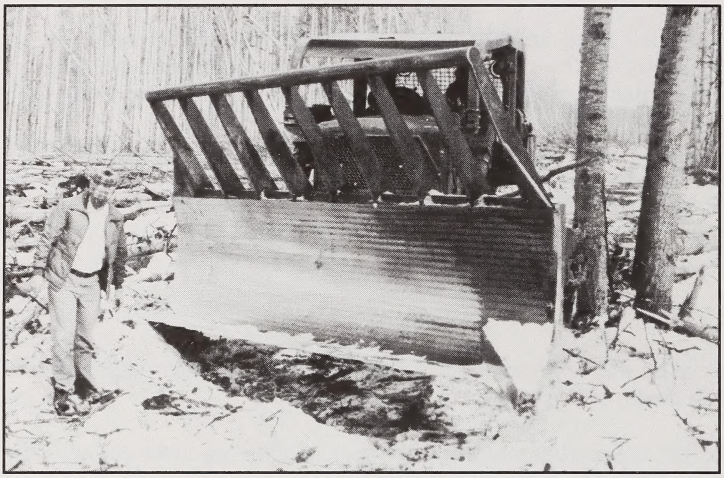

FIGURE 1. *Sidecutter. Note the brush bar on the top and the pointed slider on the leading edge of the cutter*

The sidecutter consists of a single concave blade attached to the C-frame of the crawler tractor at about a 35-degree angle. The leading edge of the blade consists of an extended point which guides the blade and functions as a slider to prevent the blade from cutting into the ground.

The cutting edge runs the full length of the blade from the pointed slider to the heel. Replaceable cutting edges may either be serrated or straight. A brush bar (may be an open framework or solid sheeting) extends upward and forward from the top of the blade.

Small trees are sheared by the angled cutting edge and are directed to the right by the upper brush bar. With larger trees, both the blade and brush bar strike the standing tree. The brush bar exerts pressure on the tree trunk to help the blade shear the stump at ground level. The amount of pressure exerted by the brush bar will vary with bar height, forward extension and tree size.

In small tree cover, brush is cut at ground level in one continuous swath, and growth is directed to the side by the blade angle and brush bar. However, in heavier cover there is a tendency for trees to fall in front of the cutter and bunch up. The crawler tractor must then back up to push brush aside, resulting in lost time. Because all severed growth is directed to one side, the sidecutter may be hard to work in a back-and-forth pattern unless cover is very light.

With the sidecutter's single, angled blade design, side forces are developed that cause the tractor to swing to the left. Denser, larger trees provide increased resistance. Under these conditions, excessive side thrust makes the blade hard to control and increases track, front idler and steering clutch wear.

The sidecutter generally shears a narrower swath than does the same power unit with a V-cutter. The V-cutter design reduces side thrust and concentrates horsepower down the centerline of the tractor, enabling it to handle a wider swath.

The proper size of tractor/sidecutter combination works well in areas of light to medium cover. It is well suited to specialty situations such as pipeline or roadway clearing because debris is thrown to one side only and can be easily piled. This procedure works well where the acreage to be cleared is not a significant factor in the total cost of the project. At any point where side thrust is significant and large acreages are involved, it may be more desireable and economical to look at another clearing method.

1.1.1.2 V-Cutter

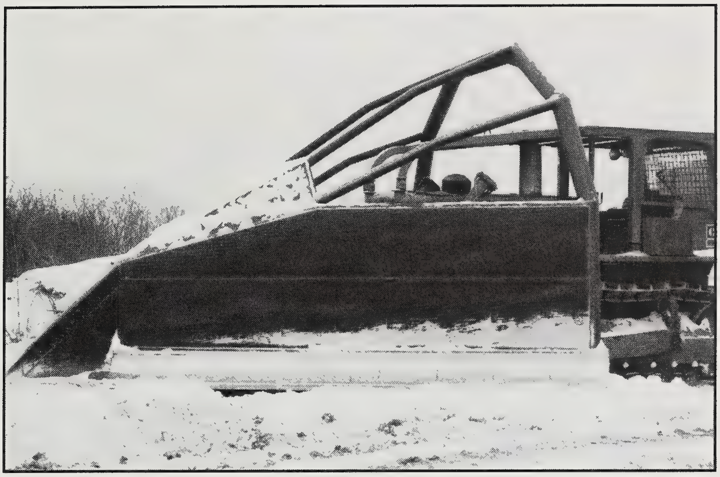

FIGURE 2. V-*cutter. Note the pointed slider on the front and the blade along the full length of the side*

The V-cutter consists of two cutting blades mounted on a framework in a V shape. The crawler tractor fits inside the open-ended V where the cutter attaches to the C-frame.

A slider leads the V-point of the cutter. The horizontal cutting blades may be serrated or straight edged with widths of 12 to 18 in. (30 to 45 cm) and lengths up to 23 ft. (7 m). The blades attach to sidewalls which normally extend up and over the tractor to serve as a cabguard.

The V angle at which the blades join varies, although most cutters have an angle of 60 degrees or less. The smaller angle design decreases forward resistance and results in an increased cutting advantage.

As the tractor pushes the V-cutter forward, the blades travel at ground level. The pointed slider guides the cutter, dislodges deadfall and prevents the blades from cutting into the ground.

Blade width determines the size of tree which can be cut. If the tree diameter at ground level exceeds blade width, it will be partially cut and then pushed over. Cut trees are directed to both the left and right sides and are left parallel to the line of travel by the forward motion of the tractor. This enables the piler to work more effectively.

The V-cutter may be used in a circular or square pattern working toward the centre of the plot, or may be worked back and forth in a long pattern. The clearing pattern chosen will affect piling costs and determine windrow layout.

V-cutters vary widely in size, design and quality of construction. Maximum cutting production is obtained by matching equipment to the work so that the tractor has sufficient power to move forward continuously. For large acreages where cutting is the desired method of clearing, the V-cutter is recommended.

1.1.1.3 Factors Affecting Cutting With Push Blade Attachments

In this report, cover size is referred to as:

Small	- less than 4 in./10 cm in Diameter Breast Height (DBH)
Medium	- 4 in./10 cm to 10 in./25 cm DBH
Large	- larger than 10 in./25 cm DBH

Cover density (number of stems per acre) is based on Alberta Forest Service density classes:

	CLASS	CROWN DENSITY
Light	A	6 - 30%
Medium	B	31 - 50%
Heavy	C	51 - 70%
Dense	D	71 - 100%

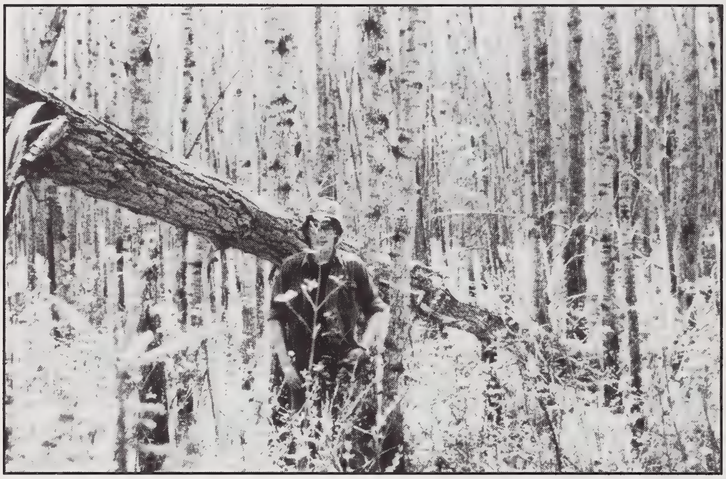

FIGURE 3. *Medium poplar cover found in the* Peace River Country

The size and density of cover which a particular crawler tractor/cutter combination can handle is limited by cutter design, horsepower of the crawler unit and traction. The crawler tractor must have enough weight and horsepower to keep forward momentum. If cover is too large for the cutter, time is wasted by backing up and/or cutting trees on two sides to fell them.

In very small cover, cutting is the recommended clearing method. While sidecutters can clear light to light-medium cover, a large crawler tractor (i.e., D8K caterpillar) with a V-cutter should have no problem clearing medium to medium-heavy cover. A dense cover of large trees can be cut given enough time, but this is generally more expensive than walking trees down.

Cutters may be lifted to achieve a mechanical advantage, thereby cutting trees off above ground level. These stumps should be recut to ground level if possible. The practice of high stumping is undesirable as stumps and/or partially severed trees increase piling time. The roughness of high-stumped fields will also increase breaking costs.

Most clearing in the Peace River area is completed during winter months when soil is frozen, because:

- all low areas to be cleared are accessible when the ground is frozen;
- soil disturbance is reduced, so there is less possibility of getting dirt in the windrows;
- snow and frost help hold small trees upright for cutting;
- reduced abrasion because of snow cover decreases blade wear and maintenance;
- cooler operating conditions reduce the fire hazard to crawler tractors; and
- during winter, many farmers have the time to hire machinery or do the work themselves.

Clearing may be done at other times of the year on well-drained areas. Larger trees are easier to cut when wood is not frozen, but there may be a tendency for partially cut and/or shallow-rooted species to push out rather than cut cleanly, and small brush will simply bend over. Blade wear due to friction will increase, and equipment must be well designed to avoid soil disturbance.

Cutters work best on level ground because the long, rigid cutting edges on large machines cannot follow abrupt ground variation. The shorter sidecutters would be better able to follow uneven ground than the V-cutters. Cutting usually results in minimum soil disturbance and less dirt in the windrows. These windrows then burn better, reducing repiling costs. Surface rock can cause severe damage to blade edges. Where excess rock is present, clearing by walking down should be considered.

1.1.2 Rotary Mowers

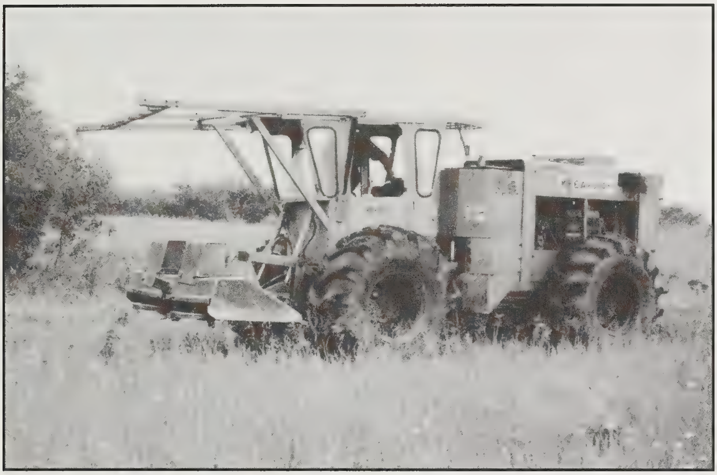

FIGURE 4. *Self-propelled rotary mower*

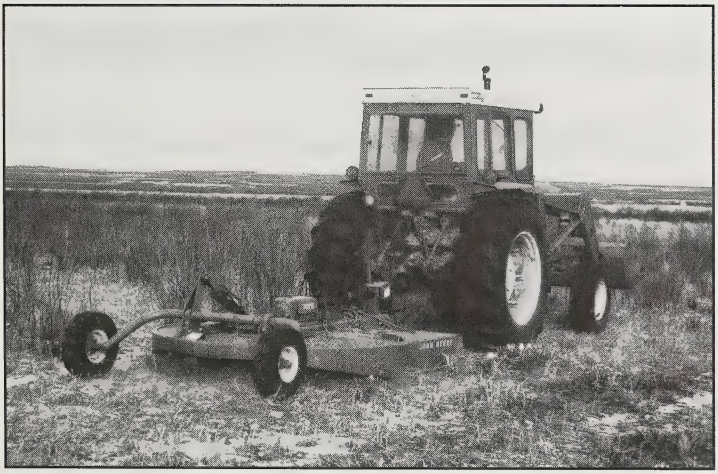

FIGURE 5. *Pull-type rotary mower*

Rotary mowers consist of one or more powered blades which are designed to sever and shred above-ground vegetation. Mowers come as pull and integral (3-point hitch) types, boom attachments or self-propelled models. They range in size from small mowers suited to cutting grass and the occasional shrub, to large machines capable of mowing and mulching trees up to 4 in. (10 cm) in diameter.

1.1.2.1 Pull and Integral Mowers

These models are the most common rotary mowers because they are economical, available in several sizes, and may be used with most standard farm tractors.

The mowers have one or more power take-off or hydraulically driven rotors. Replaceable blades of various types are bolted to the rotor(s) and rotate horizontally to the ground. The blades may be flat for brush cutting, suction for grass cutting or dual (1 flat and 1 suction) for shredding. The RPM of the rotors varies with the model, but speeds of 600 to 900 RPM are standard. Rotors and blades are boxed with solid metal top decks, and solid, chain or rubber shields. Single rotor mowers have swath widths of 5 to 7 ft. (1.5 - 2.1 m) while multi-rotor models have cutting swaths from 10 to 20 ft. (3 - 6 m). The large multi-rotor models may have hinged, one-rotor sections that fold up for transport or when a narrower-cut swath width is desired.

Pull-type models trail behind the tractor supported by side wheels. Cutting heights of 0 - 12 in. (0 - 30 cm) are adjusted hydraulically. Integral models are mounted directly onto a 3-point hitch which allows for a greater height adjustment.

As the tractor moves forward, vegetation in front of the mower is bent over by the momentum and weight of machinery. In light brush, many operators will mount a loader or dozer blade on the tractor to act as protection and assist in knocking down growth to feed under the mower.

The degree of shredding and mulching depends on the blade type, sharpness, RPM and tractor speed. Side shields help retain vegetation until mulching is complete, while rear shields are designed to spread shredded material evenly. Where one pass does not give adequate mulching, additional passes at lower heights may be necessary.

1.1.2.2 Boom Mowers

These rotary mowers consist of hydraulically powered rotors with solid metal shielding. They are attached to the boom in place of the normal bucket attachment on an excavator, or in place of the side-blade on a grader. The extent of reach and maneuverability (i.e., some excavator booms have a 360-degree turning radius) of the booms allows great flexibility in positioning the mower. On light vegetation, the mower can be moved along at ground level, while on taller brush the boom is raised so the mower can be lowered onto the tops of trees. As cutting progresses, the mower is continually lowered until brush is trimmed to the desired height. When mowing in this manner, the shields do not contain the debris and wood is thrown in all directions. Mulching is done after growth is mown to the level where the shields keep the wood in contact with the blades.

Boom mowers are best suited to very specialized clearing operations (e.g., bridge approaches, railway grades, roadsides, rough terrain, ditches, etc.). Their main advantage is that the boom arm allows access to areas which are inaccessible to other machinery.

1.1.2.3 Self-Propelled Mowers

The self-propelled models are the most powerful, heavy-duty rotary mowers available. Specifically designed for mowing brush, these mowers are not just attachments but an integral part of the tractor unit. Mowers are front mounted and usually consist of two hydraulically driven rotors.

Tractors may be either track or wheel type and range from 100 - 200 hp in size. Cabs are placed forward of the engines for better vision, and many models have a metal brush bar extending from the cab roof. Brush bars are also attached to the mowing table to help bend vegetation and feed it under the blades as the tractor-mower moves forward. The mowing table may be tilted and height adjustments range from about 0.5 - 14 ft. (.15 - 4 m) depending on model. Cutting swath widths of 7 - 10 ft. (2 - 3 m) are standard.

The degree of mulching varies with size and type of vegetation, blade rpm, number of passes and tractor speed. In tall or heavy vegetation, the mowing table is raised several feet to obtain a mechanical advantage. It is then progressively lowered until trees are trimmed to the desired height. Ground crews with chain saws may accompany the machine to hand-fall larger trees. The mower is then used to mulch the fallen vegetation. Several passes at lower heights may be needed to complete mowing/mulching.

1.1.2.4 Factors Affecting Rotary Cutters as a Clearing Method

The main advantage of rotary mowers is that their mode of action results in little soil disturbance and they eliminate the need for piling since above-ground vegetation is mulched and spread over the surface.

Pull and integral mowers are routinely used to control brush regrowth on power and roadside rights-of-way, pastureland, etc. On light brush, they are the most economical mower because of their low capital cost. Self-propelled models are more expensive and better suited for rougher terrain and larger vegetation. However, for large-scale agricultural clearing or larger tree cover, alternative machinery is widely available, faster and more economical. All rotary cutters can easily be damaged by solid objects such as stumps, rocks or frozen anthills.

1.2 Walking Down

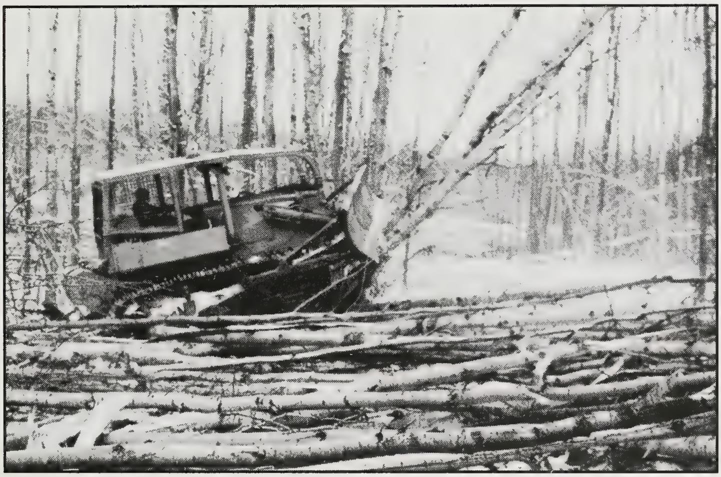

FIGURE 6. *Crawler tractor "walking down" medium density poplar cover*

"Walking down" is one of the more common methods of clearing brush in the Peace Country because of the widespread availability of equipment. Dozer blades of many sizes and designs will work. They are attached to the C-frame of the crawler tractor, either straight on or angled to one side as desired. The tractor pushes the blade into a tree at a height of 1 - 4 ft. (.3 - 1.2 m) above ground, knocking the tree over. The blade can be raised to obtain more leverage. This allows the tractor to "walk up" the tree trunk, thereby adding the weight of the tractor to help push over the tree. The tree is further flattened and pushed to the ground when the tractor carriage passes over it.

Brush bars are often added on top of the blade to provide additional height. This protects the tractor front and helps direct trees forward.

1.2.1 Factors Affecting Walking Down as a Clearing Method

Trees will either push out in one piece with the stump and main roots intact, or will break off above ground leaving the roots and stumps. When stumps and main roots are pushed out, soil will often adhere to them. If this problem is severe, hundreds of pounds of soil can come out with the roots, leaving a large hole in the field. This dirt problem is the main disadvantage to walking down, as fields are then difficult to level, windrows are dirty and will not burn, and repiling/cleanup costs increase in an effort to separate soil from wood. The physical characteristics of the cover and soil, together with the time of year, will determine how much of the stump comes out with the trunk. This will affect future treatments such as breaking, root raking, cultivating, etc.

It is common for deep-rooted tree species to break off at or above the ground, especially in areas of finer-textured soils that are frozen hard. If snags result, or trees are still semi-attached to stumps, piling costs may increase. After piling, land walked down under these circumstances resembles land cleared with a cutter because only top growth has been removed and most of the roots/stumps are still in the ground.

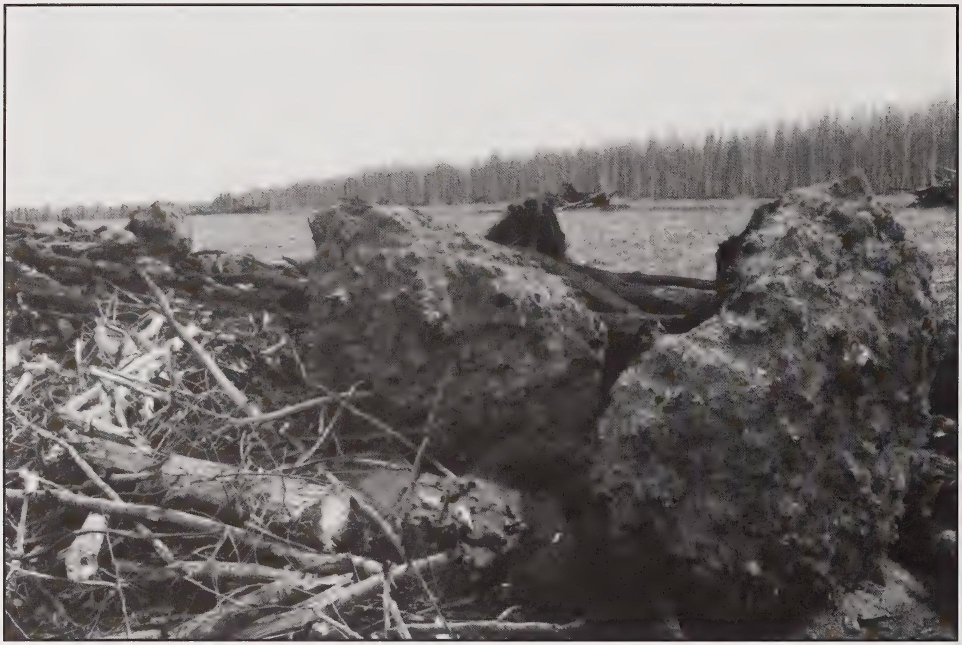

FIGURE 7. *Walked down brush. Note dirt on stumps and the poor burn*

1.3 Chaining

Chaining is a relatively uncommon clearing method. While specific setups will vary, all chaining assemblies involve two or more crawler tractors moving parallel to each other with a chain, cable, or chain and ball between them. Trees between the tractors are pulled over by the chain/cable as the tractors move forward. The distance between tractors (swath width) depends on tractor horsepower, cover size and topography and usually ranges from 60 - 200 ft. (18 - 61 m). Tractors are normally equipped with dozers or brush rakes to protect cabs and walk down brush in front of the unit. Strikeouts are often cleared at desired swath widths prior to chaining, thus allowing tractors to travel on cleared land. Normally, operators have radios or some other form of communication between tractors to co-ordinate movement.

As the crawler tractors move forward, the chain/cable contacts the trees and begins to climb up the trunks, pulling the trees forward and over. If the chain/cable climbs too high, the tree may bend over and spring back upright, or it may break off the tree several feet above the ground, leaving a snag. Some ground clearance is both necessary and desireable to provide increased leverage. This ground clearance factor is the principle behind using a steel ball filled with cement.

The ball, ranging from 3 - 9 ft. (.9 - 3 m) in diameter, is attached to the center of the chain by swivel links and rolls along the ground. It maintains ground clearance, prevents the chain from climbing too high, pulls the chain into a V shape to help windrow brush, and helps compact downed trees when passing over the brush. When cover size increases, and more power is required, swath width is narrowed. In any given swath, downed trees lie in one direction which facilitates piling. The optimum size ball, based on a report by the British Columbia Forest Service, is 8 ft. (2.4 m) in diameter and weighs l8.5 tons (17 tonnes).

1.3.1 Factors Affecting Chaining as a Clearing Method

Because the mode of action for chaining is similar to that of walking down, many of the same concerns apply as described previously. Two of the most important factors influencing use of this method are equipment availability and size of area to be cleared.

There are very few contractors with a chain/cable or ball setup. The difficulty and expense of obtaining proper anchor chain and/or a custom-made steel ball, combined with the extra handling and hauling costs, are prohibitive. This clearing method is well suited to work where large acreages will help offset costs, and crawler tractors have the room required to maneuver. The high per hour clearing capacities of l0 to 20 acres/hour, excluding piling, make it one of the most economical methods available. Although this method can be used for agricultural clearing, much of the work done in British Columbia involved large clearing projects for dam basin reservoirs and burned-over forest stands.

As with walking down, the time of year, soil and vegetation type will influence whether stumps/roots are pulled out with the tree, and how much dirt adheres to the root system. Chaining is not recommended for small cover, as trees tend to bend over and spring back. The heavy chains/cable and/or ball follow the ground well and can, if desired, clear brush growth from ravines and other rough terrain.

2.0 PILING

Fallen brush left by most clearing operations must be disposed of. Burning is the easiest, most common method used. The best way to ensure a good burn is to pile brush together in a compact, systematic way that concentrates fuel.

2.1 Piling Machinery

Brush is piled into rows with the use of specialized push blade attachments (i.e., brush rakes, piler blades, dozer blades, etc.) which fit onto the front of a crawler or rubber-tired tractor. Crawler tractors are most often used because of their greater traction, but rubber-tired tractors can be used on very light cover or for clean-up purposes.

The tractor and piler attachment move forward at right angles to the cleared brush, pushing it into windrows. Piler design, traction and tractor horsepower will affect distance between windrows.

Most piler attachments fall into one of three groups: brush rakes, piler blades or dozer blades. These are described in the next two pages.

2.1.1 Brush Rakes

The main feature that sets brush rakes apart from other piling attachments is their long, widely spaced teeth which allow wood to be sifted from snow and dirt. The rakes consist of a concave lattice or solid frame with teeth up to 24 in. (61 cm) in length, spaced 20 - 24 in. (51 - 61 cm) apart along the bottom of the frame. Total heights vary up to 8 ft. (2.4 m). The teeth are normally hard-surfaced and replaceable.

Brush rakes are often used to "rough pile" large trees. Because much debris can slip between the widely spaced teeth, a second or clean-up pass may be required to finish windrowing all brush. This is normally done with another piler/dozer, as it is not efficient for the rake to "gather" small debris.

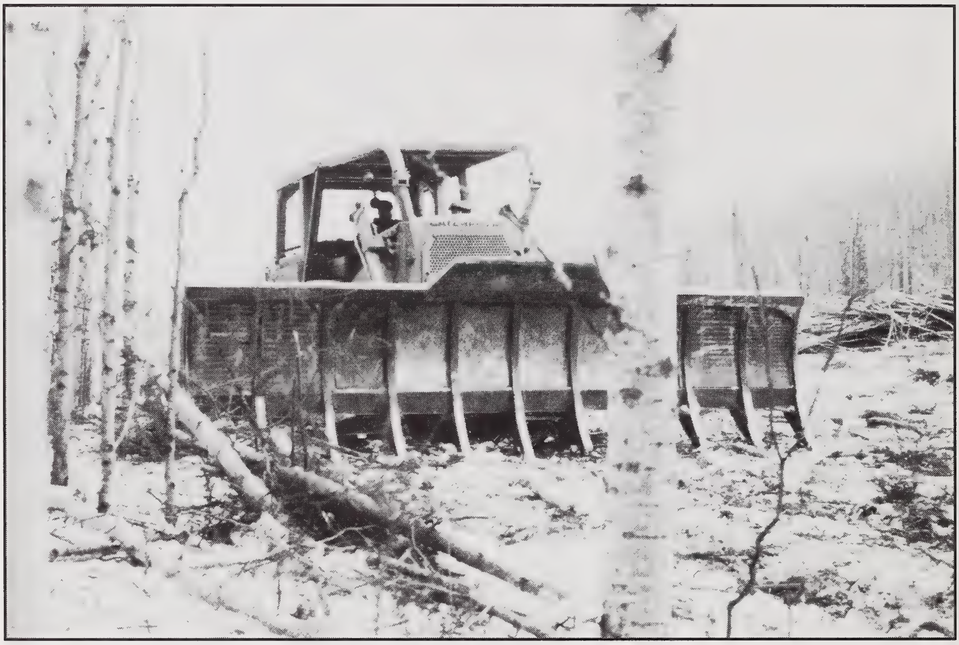

FIGURE 8. *Brush rake. Note the wide spacing of the teeth*

2.1.2 Piler Blades

These are all-purpose blades which can both rough pile and do finish work. They are often homemade and come in a wide variety of sizes and designs, from flat-faced versions to concave models.

Relatively short teeth of 8 - 10 in. (20 - 25 cm) are attached at 12 - 18 in. (30 - 46 cm) intervals along the bottom of the blade. Skid plates or shoes on the underside of the blades carry the piler weight and guide it over the ground surface, thus limiting soil disturbance. The short, closely spaced teeth prevent wood loss but allow snow and soil to sift through. Piler sizes vary and are matched to tractor size/horsepower. Heights range up to 10 ft. (3 m) with widths up to 22 ft. (7 m).

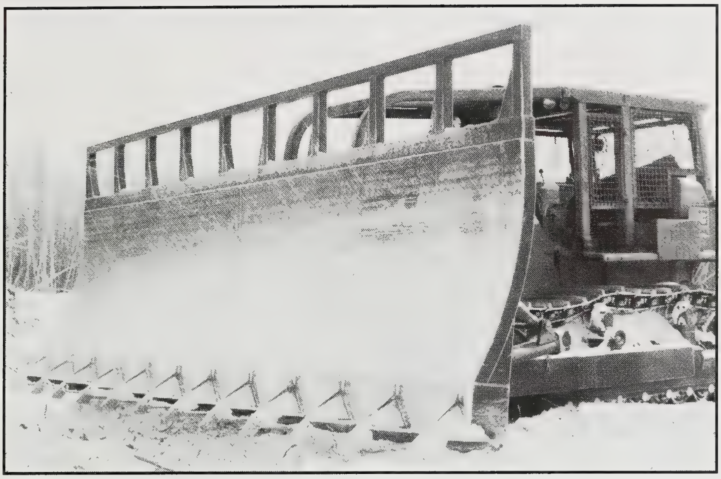

FIGURE 9. *Piler blade. This is a good design which can push a large brush load*

2.1.3 Dozer Blades

Because dozer blades are common and may already be on site, they are frequently used to pile as well. Operators must take care to minimize soil disturbance, as the absence of teeth may result in soil and snow being pushed into the windrow along with the brush.

With total heights of 5 ft. (1.5 m) or less, the brush load capacity of dozer blades is very limited. They work best on light brush or on a second clean-up pass. For large clearing jobs, toothed pilers/rakes are recommended since they allow piling of clean windrows, minimize soil disturbance, and make better use of tractor horsepower because of their larger brushload capacities.

2.2 Windrow Layout and Construction

The layout of brush windrows affects burning and tillage. Fallen brush is easiest to pile at right angles to the direction of clearing, so the clearing pattern should be selected with this in mind. The layout should accommodate water movement, as piling across slopes, runoff channels or low areas will interfere with drainage and cause water pooling. Slow drying of the ground and piled brush can result in a poor burn or incomplete breaking. Fallen brush in low areas should be piled on higher ground if possible, and breaks should be left where needed to allow runoff. Breaks in windrows must also be planned to accommodate machinery movement throughout the field and to meet fire regulations.

Space parallel rows as far apart as possible. Where machinery and cover size are well matched, 200 ft. (61 m) between rows would be standard. Where other factors have been considered, windrows are often laid out parallel to prevailing winds, as this can give a more even burn than can a cross-wind.

Provincial and/or local regulations for fire permits also affect windrow layout. In Alberta, windrows on lands under the jurisdiction of the Forest and Prairie Protection Act must meet the following minimum specifications:

1. Windrow maximum length is 60 m (197 ft.) with an 8 m (26 ft.) break between each 60 m length.
2. Parallel windrows must be separated by a minimum 15 m (49 ft.).
3. The area to be burned is to be completely surrounded by a guard cleared of inflammable material to a minimum of 15 m (49 ft.).
4. No windrow is to be closer than 25 m (82 ft.) to uncleared land or standing fuels.

All debris should be piled. Trash left between windrows or along field edges will interfere with tillage and eventually have to be removed by other methods. Any standing tree left on the field after clearing should be knocked down and windrowed when piling. Standing trees should never be left in a windrow since they do not burn well.

Rows should be marked out prior to piling to ensure even spacing and straightness. Crooked, scruffy windrows should be trimmed by pushing in stragglers and ends. Loose, dirty windrows will burn poorly, so soil disturbance should be minimized and wood piled as compactly as possible.

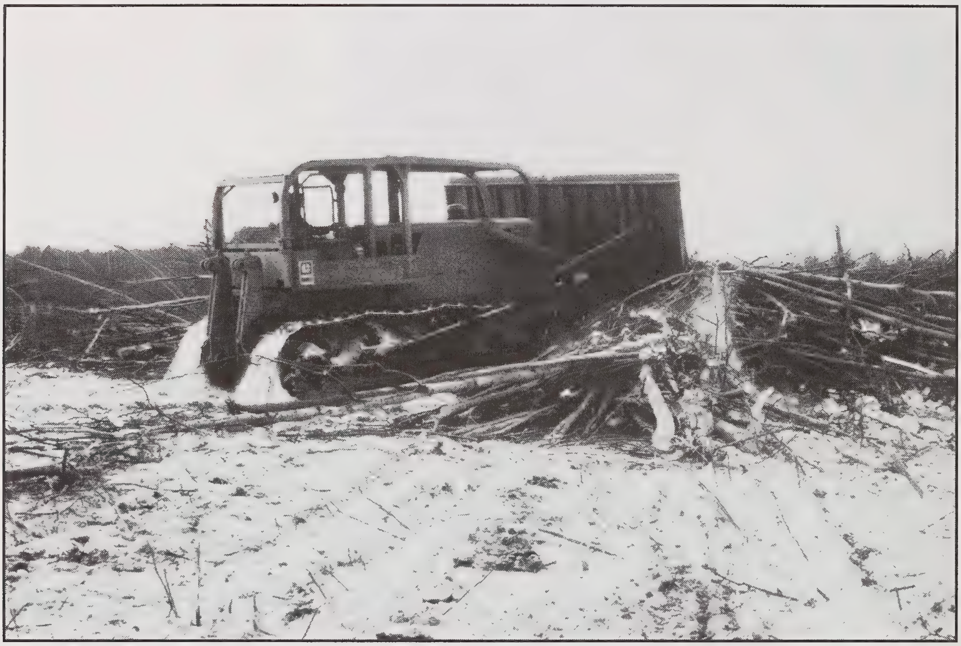

FIGURE 10. *Piling brush*

2.2.1 Factors Affecting Piling

The quality of clearing will affect the ease with which brush is piled. High stumps, snags or trees partially attached to the ground will interfere with piling. Several passes may be required to complete piling resulting in longer piling times and higher costs.

A delay between clearing and piling can result in downed trees freezing to the ground, so piling should immediately follow clearing. Any breaks in windrows, trimming, etc., must be done right away because frozen windrows may be impossible to move.

Large amounts of snow will affect how far machinery can push debris and can make windrows hard to compact. Piling can be done in the summer, but wet areas may be inaccessible and more soil disturbance will occur.

2.2.2 Burning

Although windrow layout and construction affect burning, the size, type and dryness of fuel together with humidity, temperature and windspeed may be the most important factors in a successful burn.

Small vegetation cover and conifers will burn more readily than large aspen and balsam poplar. Recently cleared brush burns better after seasoning, but can become punky and hard to burn if left too long. Good results can be obtained the first season after clearing once deciduous trees in the windrow have leafed out and dried.

On humid days, wood will take on moisture and not burn well. A hot, slow burn is the most effective and in some cases, almost 100 per cent disposal can be obtained this way.

Burning is often taken for granted, but should be given careful consideration. The care taken to lay out and build good windrows can be wasted if piles are carelessly lit, resulting in a poor burn and high repiling costs.

2.2.3 Repiling

After windrows have been burned, some wood will usually remain. This must be repiled and reburned for satisfactory disposal. Since most repiling takes place in the summer and fall, a toothed piler blade is necessary to separate dirt from wood. The repiles should be clean, compact and as far apart as possible.

If the field has been broken between the windrows, repiles can be placed on the breaking which allows the former windrow site to be broken. Repiles can then be burned/repiled/reburned, etc., for total disposal, or burned down to the point where the remaining wood can be raked into root windrows if the field is going to be root picked. Hand removal of some long logs and stumps may be required.

3.0 BREAKING

The objectives of breaking include cutting off and loosening stumps and roots, turning under top growth and mulching the soil so it can be worked into seedbed condition.

The three methods of breaking in the Peace River region are mouldboard ploughing, disc breaking and rotovating. The method selected depends on the clearing job obtained, cover size, topography, stoniness, soil texture, size of field, availability of equipment and cost.

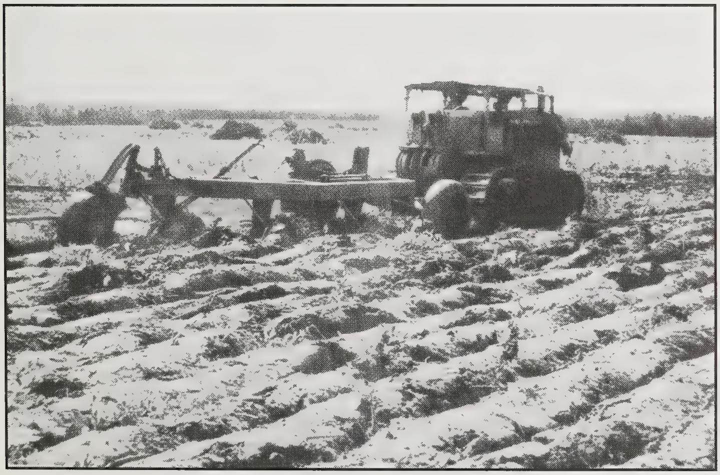

FIGURE 11. A 3-*bottom mouldboard plough*

3.1 Mouldboard Ploughing

The plough is an ancient tillage tool. It can range in size from the single bottom, horse drawn plough, to the massive breaking ploughs pulled by crawler tractors.

Mouldboard breaking ploughs vary in size from one to five "bottoms". Each bottom may be from 18 - 26 in. (46 - 66 cm) wide. As the plough is pulled forward by the tractor, each bottom travels along at the desired depth below ground level, cutting a furrow slice of soil and inverting it completely so that all top growth and trash are buried.

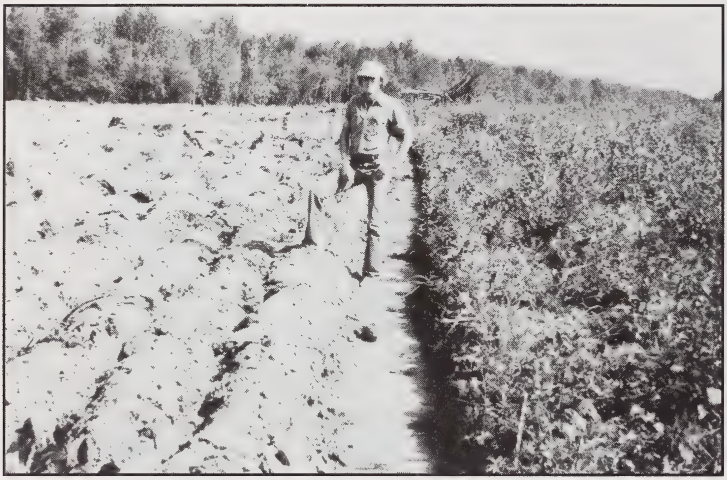

FIGURE 12. *Mouldboard ploughing. All vegetation has been turned down*

Plough bottoms are attached by standards to a main frame. Some smaller one or two bottom models can attach to a 3-point hitch which controls ploughing depth. Most models are pull-type implements supported by wheels. Ploughing depth is controlled hydraulically or by cables. Crawler tractors are used on most ploughs because of the traction required (i.e., a four bottom plough would require a D8 caterpillar). Rubber-tired tractors are occasionally used with one or two bottom ploughs; however, traction can be a problem and there is considerable risk of puncturing tires.

The leading edge of each plough bottom consists of a downward angled coulter tip attached to a sharp, vertical wall called a coulter. This tip initiates soil penetration, while the coulter slices the soil vertically, splits stumps and cuts trash. The tip and cutting edges are hard-surfaced to minimize wear. Tip angle and coulter wear affect penetration, so regular maintenance is necessary. The vertical coulters are flat on one side. This flat or "landside" runs against unploughed ground, absorbing side forces, preventing horizontal movement and steadying the plough. The other side of the coulter is attached to a wide (18 - 24 in./46 - 61 cm) horizontal blade edge called a "share". The share provides suction and penetration as it travels underground at the desired depth and cuts the furrow slice loose. The share angles back and up to the mouldboard.

The mouldboard consists of rods or a solid framework that continues the extension back, up and out. The furrow slice starts to lift and turn as it travels up the share, and the mouldboard completes the lifting-turning action. The furrow slice is inverted and placed neatly to the side into the space vacated by the furrow slice from the plough bottom in front. Thus, the last bottom on all ploughs inverts a furrow to one side and leaves its own cut unfilled. This is called a dead furrow. Dead furrows will be filled on the next round if adjacent ground is ploughed in the same direction. Plough patterns that minimize dead furrows should be selected, because a large number of these furrows make the field hard to level prior to other tillage operations.

Most breaking is from 4 - 8 in. (10 - 20 cm) in depth. Shallow ploughing does not sever roots and the furrow may not turn properly. Deeper ploughing buries topsoil and requires too much power.

All land in the field should be broken. Often small strips are missed between plough passes or on corners. These interfere with future tillage passes and promote regrowth of brush.

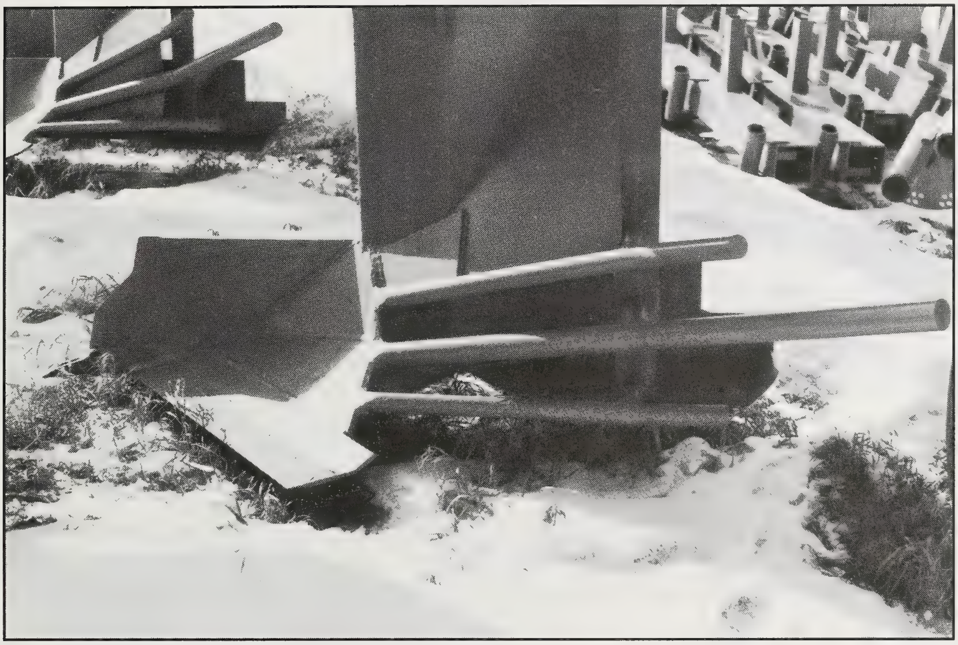

FIGURE 13. *Detail of a mouldboard plough bottom*

3.1.1 Factors Affecting Ploughing

A variety of factors including topography, soil conditions and stump size affect ploughing. Mouldboard ploughing is recommended where any large amount of stump/root material remains after clearing, because the plough can split, loosen and turn out the stumps. Stumps and roots remain in large pieces so they are easier to root pick. When ploughed, trash is buried so it does not interfere as much with future tillage operations. Heavy multi-bottom ploughs are more stable and less likely to jump sideways around a stump than one or two bottom models. Very large stumps may need to be grubbed out with a dozer blade before ploughing.

Plough size should be matched to field acreage and topography. Large four or five bottom units pulled by crawler tractors are very long and may do a poor job on rolling topography that has abrupt ground level changes. A two bottom plough would do a better job in such circumstances and is more maneuverable on small fields.

Although tips and cutting edges can be damaged by rock, the plough can loosen surface and subsurface rock and will often do a better job of breaking rocky land than a disc.

3.2 Disc Breaking

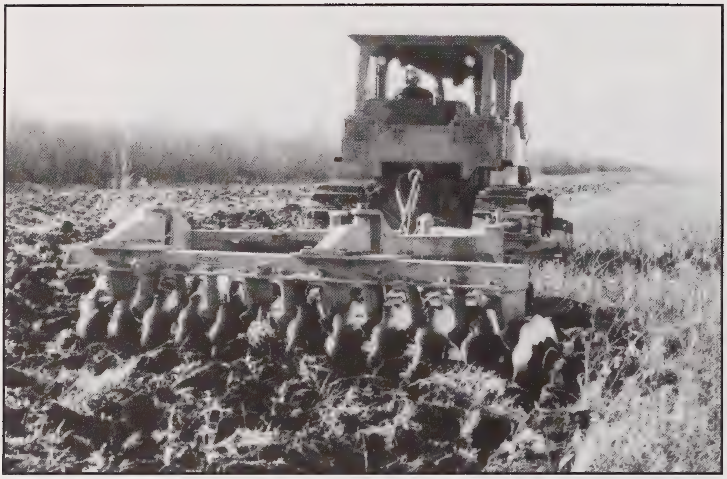

FIGURE 14. *Cat and Rome breaking disc. Note serrated blades*

Breaking discs have heavier frames, large blades, wider blade spacing and greater overall strength than the common farm field disc. Large breaking discs are most often pulled by crawler tractors, especially for the first pass in rough conditions. Rubber-tired tractors are often used on subsequent passes or matched to smaller discs.

The two main designs of discs are offset and tandem. Both types are available in a wide variety of widths and weights. Single offset discs have two gangs, one in front of the other, while tandem (double offset) discs have two opposed front gangs and two opposed rear gangs. Most breaking discs are offset.

The angle(s) between front and rear gangs adjust on all discs and can vary from 0 to 60 degrees depending on the model. Correct angle adjustment depends on conditions and is an important factor in disc performance. Increasing the angle of gangs improves penetration and trash coverage.

Disc blade design, thickness, diameter and spacing will affect performance. Most disc blades are shaped like portions of a hollow sphere. The degree of concavity varies. Deeper blades plug more easily than shallow blades, but they move more soil and have a better pulverizing action. Notched disc blades penetrate better than plain blades because of the reduced contact area on the outer edge. They are often used on front gangs to increase trash cutting and penetration, with plain blades on the rear gangs to improve pulverization and levelling.

Common breaking disc blade diameters range from 28 - 36 in. (70 - 90 cm). Diameter affects penetration. As a general rule, most blades have a penetration of about l/3 of their diameter in loose soil conditions.

Blade thickness of 1/4 - 1/2 in. (6 - 12 mm) are standard on breaking discs. The thicker blades add strength and weight to the disc, but do not penetrate as well. Thicker blades wear longer and may be placed on front gangs to compensate for the faster wear of front blades. Generally, hard surfaced blades have a longer work life, but wear varies with the soil conditions.

Wide blade spacings on breaking discs allow better trash clearance and deeper discing. Typical blade spacing would range from 12 - 16 in. (30 - 41 cm). Blade spacing is an important factor when comparing disc weights.

The weight per blade measurement gives a direct value for the downward force available on each blade. It is the total weight divided by the number of blades. Weight per foot of cutting width provides a quick means of comparing the weight of two machines with different blade spacings. For valid disc comparisons, both weights should be used. We specify a minimum weight of 325 lb. (150 kg)/blade and 575 lb./ft. (260 kg/30 cm) of cut for discs on most work in our area. However, discs with up to 1000 lb. (455 kg)/blade and 1730 lb./ft. (788 kg/30 cm) of cut are available.

The disc should be adjusted to run level for even penetration. Increased speed of operation will usually reduce penetration and increase the pulverizing action of the blades. Most breaking discs reduce trash cover by about 50 per cent on each pass by mixing and mulching the top 6 - 8 in. (15 - 20 cm) of soil. Where more than one pass is needed, extra passes should be made at angles to each other to improve performance. The rear gang on the disc will leave a furrow, and a field pattern which fills the furrow of the preceding round will maximize levelling.

3.2.1 Factors Affecting Disc Breaking

The amount of stumps, roots, heavy trash, logs and rock is the most important factor to consider in disc breaking land. When a large object is hit, an entire gang will be bounced out of the ground, leaving that area unbroken. For this reason, discs are not recommended for breaking land with a large number of stumps. They do a good job of breaking land that was cleared by walking down and has very few stumps remaining. The disc may not move enough dirt to fill in the large holes which can result when soil adheres to the stumps, so the field may require floating to fill and level these areas.

Light brush growth can be broken with a disc without clearing first. However, if regrowth is too heavy, roots and crowns are not turned out and brush regrowth can be a real problem. Heavy trash will be hard to cut and mulch, and several passes may be required to incorporate wood into the soil. Under these conditions, a mouldboard plough would do a better job.

Hard, dry soil restricts penetration while heavy, moist soils can cause the disc to plug. Land that is disced when wet may dry into hard lumps that are very difficult to work down. On rough or rolling ground, narrow swath width discs do a better job of following the ground, giving more uniform penetration than wider discs.

Discs can do a good job of breaking and are recommended where the deep ploughing, complete trash coverage and stump splitting ability of the mouldboard plough is not needed or desired.

3.3 Rotovating

Rotary tillers range in size from the manually operated garden rotovator to large self-propelled models. There are also tractor-drawn or tractor-mounted models with auxillary engines for tiller power. The heavy-duty construction and extra power of these models give them the capability necessary for primary tillage. Rotary tilling is a unique land preparation method in that tillers can be used to clear and mulch above-ground vegetation, break the soil and work it down in one operation.

Rotary tillers consist of blades attached along a horizontal rotor. Trailer-drawn models are most common in the Peace River area. They have a 250 - 425 hp motor which powers a heavy-duty rotor. The rotor rotates in the same direction as the tractor wheels, tending to push the tractor forward. Rotor diameter and length vary with make, but swath widths of 7 - 7.5 ft. (about 2 m) are typical. The rotor speed is adjustable but it can range up to 360 rpm on some models.

Blade design, size and construction vary. The size and design affect working depth, pulverization, penetration, mulching and trash coverage. Two common blade types are "L"-shaped blades and chisel tooth blades. Because of the high torque developed during each cut, blades are staggered so no two blades strike the soil at the same time. The blades are usually self-sharpening and replaceable. The size of cut or bite of a blade varies with rotor speed, number of blades and the tractor's forward speed. Small bites from high rotor rpms and slow tractor speed will increase pulverization. Working depth can be adjusted, with a minimum 6 in. (15 cm) recommended for breaking.

As the rotor moves forward, the blades chip and mulch above-ground vegetation along with small stumps, roots and earth to the desired depth. All soil cut by the blades is carried inside the rotor until it reaches the backside. Then the soil must be discharged before the blade again reaches the cutting position or plugging will occur. Rotor rpms must be properly matched to the forward speed as this affects bite size, degree of pulverization, mulching and plugging of the rotor by soil.

3.3.1 Factors Affecting Rotary Tillers

Rotary tillers are best suited to cleared areas with few large, solid obstructions, and uncleared areas with very light brush cover. Larger trees may be mulched, given enough time and enough passes, but this is not economical in most cases. If the area to be rotovated has a significant amount of tree cover, it should be cleared first. If large stumps or rocks are present, the rotovator may be damaged and another breaking method may be more appropriate.

Dry, hard soils may restrict penetration and soil pulverization can be excessive. In seedbed preparation, crusting can then be a problem on grey wooded soils common to the Peace River region. The slowest rotor speed and largest blade bite which will provide acceptable tilth are usually best. Rotovating fluffs up the soil and packing or raking may be necessary to firm the soil prior to seeding.

Depending on conditions and cover type, the pull-type rotary tillers have a capacity of 1 - 2 ac. (.4 - .8 ha) per hour. Their maintenance requirements and very high capital cost make them expensive machines to operate with high per hour custom rates. It must be kept in mind, however, that breaking, seedbed preparation and, in some cases, clearing, are included in the cost. They are best suited to specialized jobs where the one-step operation has proven benefits.

4.0 WORKING DOWN

In most cases, the end objective for land development is a smooth, level, relatively trash-free field. This can be done over a period of years where development is interspersed with pasturing, haying and cropping, or the majority of development can be done immediately after breaking and before the first seeding.

The workdown required depends on the clearing/breaking methods used, weather, soil conditions and seedbed desired. Workdown involves mulching, mixing and levelling the soil as well as removing rocks, roots and stumps if desired. The order in which this is done depends on the field conditions and machinery available.

4.1 Discing

Because discs are a common implement, they are often used to work down breaking.

The ideal workdown disc is between the large breaking disc and common farm field disc in size. We specify discs with blade diameters of 24 - 28 in. (60 - 70 cm), disc spacing of 9 - 12.5 in (23 - 31 cm) and a minimum weight of 175 lb. (80 kg)/blade and 350 lb./ft. (159 kg/30 cm) of cut.

On disc breaking, the smaller blade size and narrower spacing of the workdown disc reduces soil clod size. This is the preferred workdown implement on disc breaking.

Workdown discs may be used for the first pass on mouldboard breaking to loosen soil in preparation for other implements.

4.2 Floating and Harrowing

Floats and bull harrows are drags designed to move dirt, level the land and loosen trash from the soil. These drags are often homemade and come in a wide variety of sizes, weights and designs.

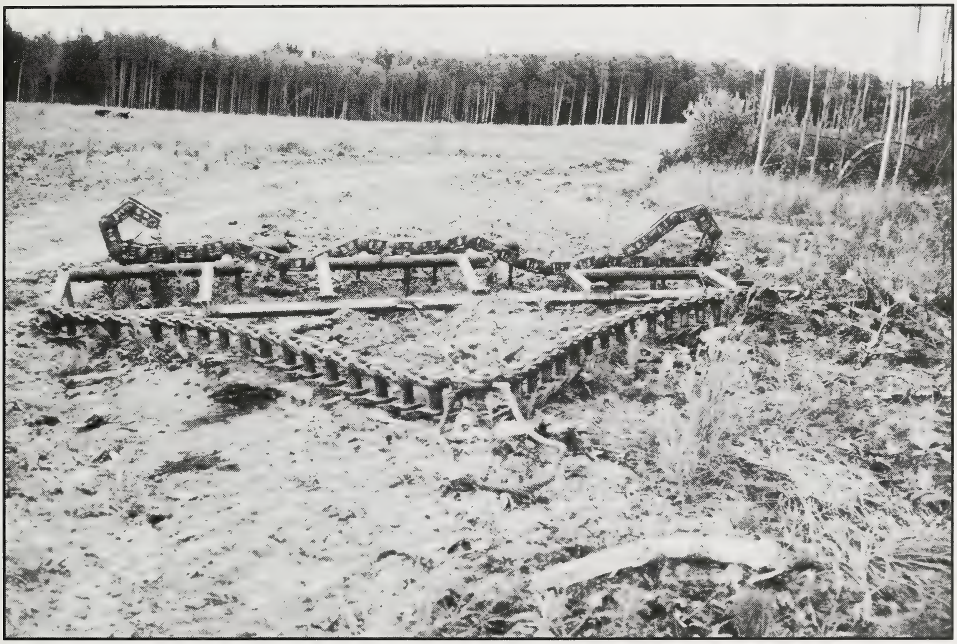

FIGURE 15. A *float can be made from cat rails*

A float must be heavy enough to move soil and level the land. Often floats come with teeth to tear trash loose. D7 or D8 caterpillar rails with teeth up to 10 in. (25 cm) long are commonly used. They are hooked to the tractor by a cable from the centre of the rail. A bar or pipe is used to keep the open end of the V at the desired swath width. This V design is better at shedding soil and cleans more easily than do drawbar or straight design floats. Floats that build up soil or trash become too heavy to drag and must be cleaned frequently.

Bull harrows are heavy-duty, flexible harrows that loosen roots and help level the field. They may be used alone or in combination with another floating device. Many drags incorporate features from both floats and harrows and are used in all situations.

To level the field, breaking must be mellow enough to allow the teeth to penetrate so loose soil moves with the float. If the ground is too hard for the float, it may be disced first to loosen the soil. Where root or rock picking will be done, the float is the preferred field preparation method. Discing should be minimized because the disc cuts and buries woody trash, making it more difficult to pick.

Several passes at different angles to each other may be required to fill in dead furrows on mouldboard ploughing or fill in holes from walked-down trees. The floats/harrows may be used at several stages throughout the workdown to improve levelling and loosen additional roots. A good job of floating and harrowing will make other procedures such as root raking and discing easier.

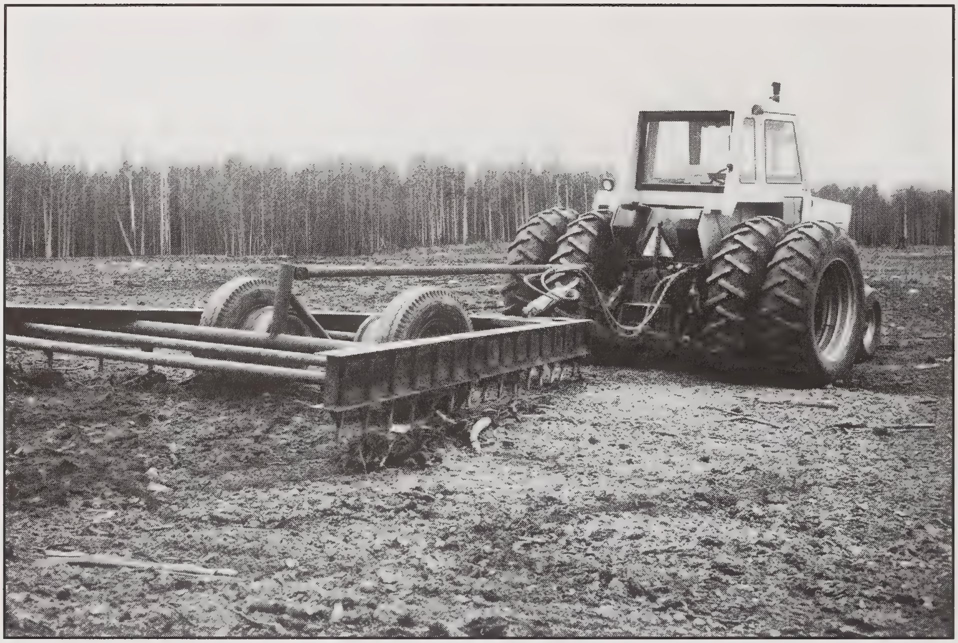

FIGURE 16. *Root harrow*

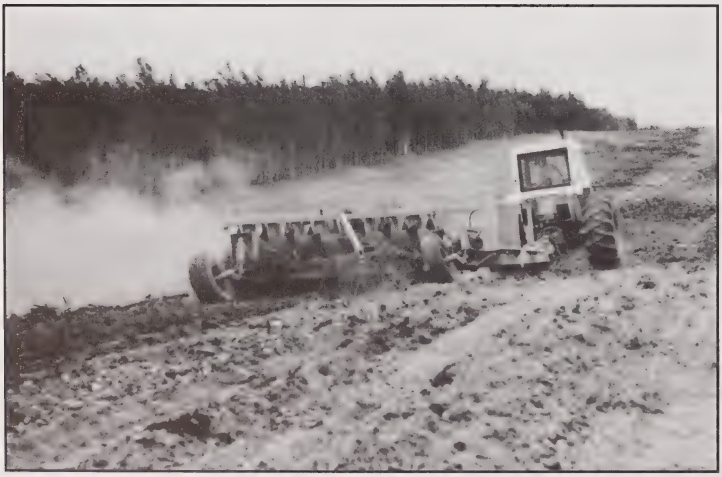

FIGURE 17. *Drum root raking. A root windrow is formed to the left of the drum*

4.3. Root Raking

Root rakes are pull-type implements that pick loose roots, stumps and rocks from the soil and windrow them using the same principle as the common side delivery hay rake. The two main types of root pickers are the drum root rake and the wheel root rake.

4.3.1 Drum Root Rakes

Drum rakes consist of a hydraulic or PTO-driven drum (rotor) which ranges up to 34 in. (86 cm) in diameter and 14 ft. (4.3 m) in length. Large 6 - 8 in. (15 - 20 cm) triangular-shaped teeth are staggered along the drum so that no two strike the ground at the same time. The rake travels at an angle and swath widths vary from 8 - 10 ft. (2.4 - 3 m) depending on the model. The drum rotates opposite the direction of travel. As the machine is pulled forward, the teeth pierce the ground surface and tumble roots and rocks ahead of the drum and out the side to form a windrow. Drum height, level and rpm are adjustable. The teeth are replaceable and are often hard-surfaced to increase wear. Worn and missing teeth will affect picking.

With its solid, one-piece construction, the drum works best on soft, level ground where trash and rocks are loose. Solid stumps, hard ground and large rocks will break teeth and damage the drum. The drum can do levelling on soft, uneven ground but may miss or drop roots where there are abrupt ground changes. In rough field conditions, it is difficult to control the amount of dirt carried along, and the windrows may be dirty. The drum can then be used to "kick" finished windrows over to help shake out the dirt. Where conditions permit drum teeth to penetrate to their full depth, they will pull out loose roots to that depth.

Occasionally, roots will stick between teeth and can be carried over the top of the drum. Some models have a shield to prevent this from happening. Generally, the drum can rake large roots, stumps and even short logs; because it is power-driven, it can handle a larger trash load than the wheel rake.

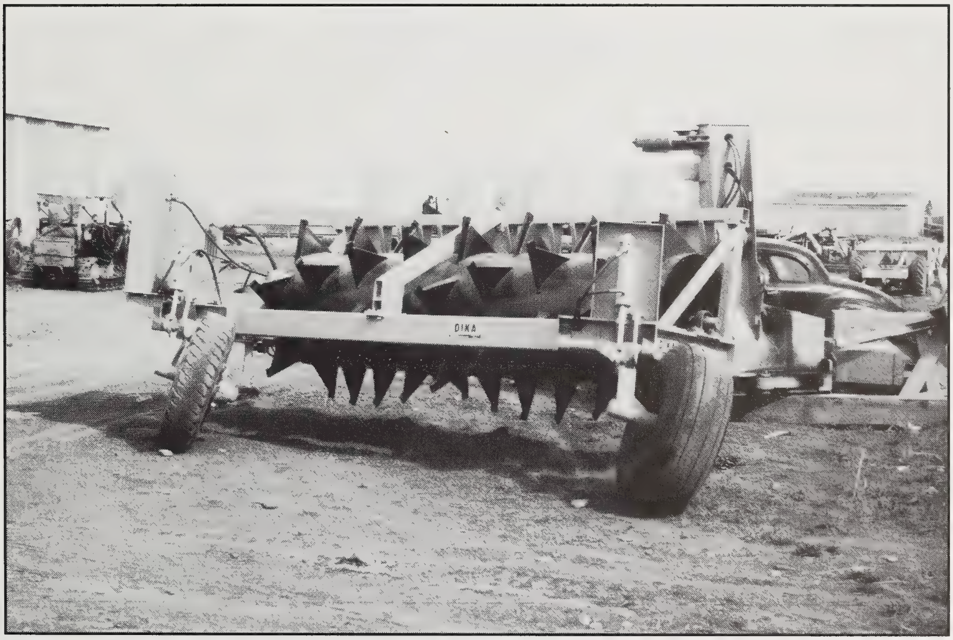

FIGURE 18. *Detail of a drum root rake*

With the high rotor rpm, and the action of the teeth as they enter the soil, the drum rake does a significant amount of tilling, levelling and packing in soft soil, but soil pulverization can be a problem in dry conditions. Roots pick up best when dry, as wood separates easily from the soil. If the soil is too moist, dirt sticks to the roots and sods do not pulverize; instead, they are windrowed with the roots.

The field is root picked in segments ("lands") 100 - 350 ft. (30 - 107 m) wide depending on the amount of trash and how far the rake can carry the windrow. The lands are worked in a circular fashion, working the windrow inward and leaving one windrow on each land. Capacities vary with conditions, but range from 1.5 - 2.5 ac. (.6 - 1 ha) per hour.

4.3.2. Wheel Root Rakes

Wheel root rakes resemble large, heavy-duty, side delivery hay rakes in appearance. They are ground-driven and available as 4, 5, 6 or 7 wheel models. The wheels range from 4 - 5 ft. (1.2 - 1.5 m) in diameter, and are individually suspended from the main frame. Angled teeth 6 - 12 in. (15 - 30 cm) long are spaced around the entire wheel circumference at 4 - 6 in. (10 - 15 cm) intervals.

Teeth may be solid and welded to the wheel, or be spring-type in design. Overall lengths for wheel rakes vary from 24 ft. (7.3 m) for 5 wheel models to 35 ft. (10.7 m) for 7

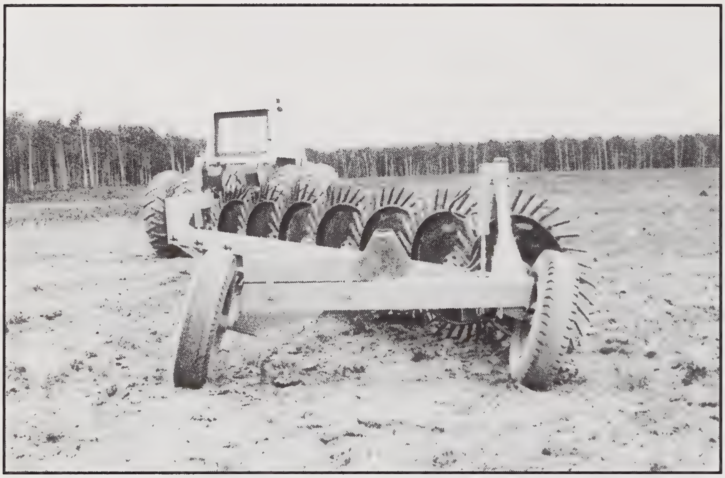

FIGURE 19. *Solid tooth wheel rake*

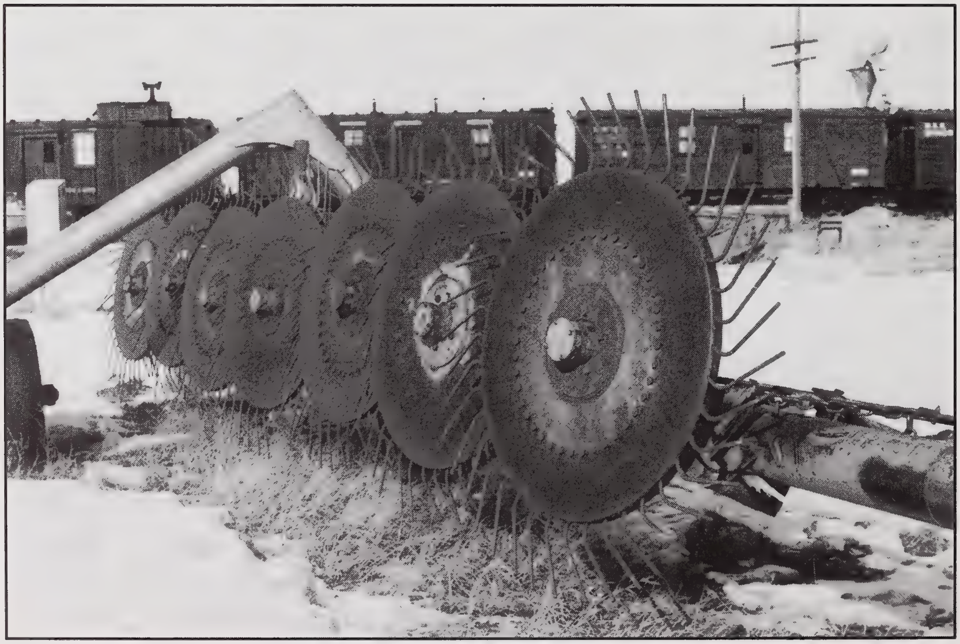

FIGURE 20. *Spring tooth wheel rake*

wheel models. The height, level and raking width angle are adjustable. Raking swath widths depend on soil conditions, root load and rake angle, but maximum swath widths of 8 ft. (2.4 m) for a 5 wheel rake and 12 ft. (3.7 m) for a 7 wheel rake are typical. Increased resistance resulting from large root loads will tend to straighten the rake out behind the tractor, decreasing swath width.

As the tractor pulls the rake forward, the teeth contact the ground and turn, tumbling roots and small rocks to the side and rear where they are picked up by the adjacent wheel. The process continues along each wheel, forming a windrow at the back of the rake. The rake angle will determine the overlap between wheels. This overlap, together with closer tooth spacing and the ability of individual wheels to follow the ground, allows the wheel rake to pick small roots and hold the wood better than the drum rake. However, the wheels may bounce over large objects and cannot move as heavy a windrow as the drum rake. Shorter rakes can follow uneven ground better than the longer 7 wheel rake.

Wheel rakes work best on a firm, level base where all material to be picked is loose and on the surface of the field. Solid tooth designs are stronger, can handle more rock and have less tooth maintenance than spring tooth models.

In deep, soft, loose soil conditions, wheel raking should be left until the soil has settled and has a firm base (i.e., after a rain). Otherwise, the rake will carry dirt into the windrow, increasing windrow load, decreasing swath width and making clean-up of rows by burning very difficult. Wheel rakes are primarily designed for surface picking roots.

Fields are worked in lands 100 - 350 ft. (30 - 107 m) wide depending on root load and conditions. Roots and rocks are progressively worked to the centre of the land, leaving a windrow in the middle of each segment. Wheel rakes provide some soil tillage, but not to the same extent as the drum rake. The high capacity of the wheel rake, 4 - 7 ac. (1.6 - 2.8 ha) per hour, and their lower purchase price makes this a quicker and cheaper method than drum root raking a field. Wheel rakes are especially useful on second and third rakings where there are fewer and smaller roots and rocks on the surface.

4.3.3 Factors Affecting Root Picking

Field preparation and proper ground conditions are the most important factors in root picking. Ideally, the drum works best on level, soft ground and can pick loose roots and rocks to a depth of 6 - 8 in. (15 - 20 cm), while the wheel rake works best on level, firm ground with roots and rocks loose on the surface.

A field may need several pickings before its condition is satisfactory. Where there is a significant amount of woody trash, the drum rake is often used for the first pass with subsequent rakings done by a wheel rake.

If several rakings are intended, the root windrows from the first raking are often left on the field and additional roots are raked to them. The heavy-duty field cultivator is a favorite implement for working the field to bring additional roots to the surface. The cultivator loosens roots without cutting them into smaller pieces that are difficult to rake. Combinations of discing and harrowing are also used. The disc will cut roots and push them down, which is undesireable, but it also loosens soil and does some levelling which may be needed. Bull harrows may then be used to firm the soil base and drag trash back to the surface for picking.

Surface rocks and roots that remain may be pushed into the ground with a land roller. This leaves a smooth, level surface and promotes rotting of woody material in the ground. After harvest, fall cultivation may be followed by another raking.

4.3.4 Windrow Cleanup

If there is enough debris to carry a fire, root rows may be burned where they lie. Fire regulations should be respected and care taken to get the best possible safe burn. If rows are too light to carry a fire, they should be bunched together in piles for burning. A wide variety of machinery may be used, but toothed piler blades will help separate dirt from roots and rocks. Small crawler tractors or rubber-tired skidders with pilers are often used. Good results can be obtained with dozer blades or buckets if they are used with care. Piling in the fall after frost, or after a rain when the soil has hardened, will minimize dirt in the piles. Wood can be burned and reburned, with the rocks and remaining trash picked up and hauled off the field for total disposal. Removal is preferred to burying, as this will eliminate problems when the ground settles.

Total disposal of all repiles and root windrows is recommended for both pasture and cropland. Repiles often become sources of weed infestation as well as interfering with field operations and livestock handling.

4.4 Rock Handling

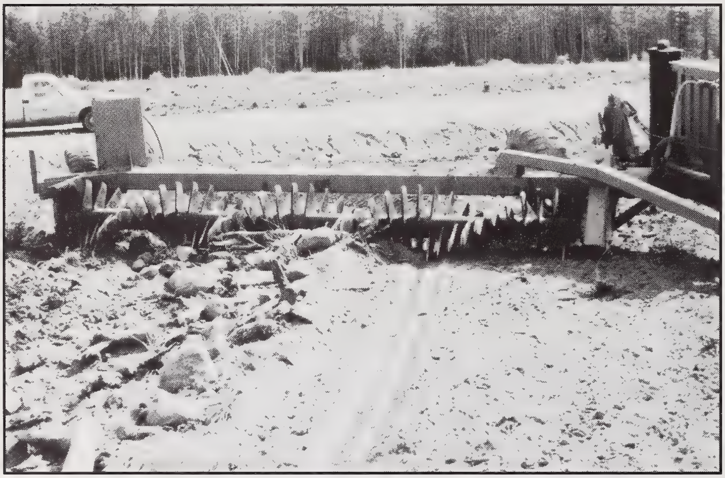

FIGURE 21. *Rock windrower*

Rocks are often removed when new land is being worked down. The rocks are loose from breaking operations and can be removed before they damage machinery in subsequent tillage operations. Rock rakes and pickers are pull-type implements that either windrow rock or pick it off the field and put it in a hopper.

Rock rakes consist of a hydraulic or PTO-driven drum with teeth which windrow small rocks using the same principle as the drum root rake. Performance depends on tooth design and configuration, drum angle, rpm, forward speed and field conditions. Greater raking angles and higher drum speed increase both raking action and soil disturbance. Most rakes will windrow rocks ranging in size from 1 - 20 in. (2.5 - 51 cm) in diameter. They work best in semi-firm, semi-moist soils and should be operated with teeth about 1 in. (2.5 cm) below the surface to minimize the amount of soil in the windrow. Once in a windrow, rocks can be picked up with a rock picker or front-end loader.

Rock pickers are used to remove rocks from the field surface. They consist of a finger grate which travels at or just below the ground surface. A rotating reel with several bats pushes rocks onto the grate and conveys them to a hopper for later dumping. Reels may be hydraulic, PTO- or ground-driven. Most reel pickers can handle rocks 2 - 24 in. (5 - 61 cm) in diameter. Performance depends on reel and grate design, reel speed, type of drive and field conditions. They perform best in fields with a firm base and minimum amounts of trash and dirt lumps. Hopper capacity and dumping techniques depend on the model.

Field preparation is the most important factor in rock handling. Rough land must be prepared by levelling the field and loosening the rock. Large rocks should be removed from the field prior to picking. Several passes with rakes/pickers interspersed with cultivation to loosen and bring additional rocks to the surface may be required.

If there is a large amount of woody trash, the field may need to be root picked first. Most root rakes can handle a certain amount of rock, but drum rakes are subject to more damage than wheel rakes.

4.5 Seeding

If the intended land use is crop production, enough care will have been taken during the preceding steps that the cereal seeds can be drilled to the desired depth. Some prefer to grow Canola for the first crop as it can be broadcast and harrowed in with fair success.

Forage seeds can be broadcast and floated in. This is an advantage in pasture development as new land usually has enough roots and debris remaining to plug drills and harrows.

There are several types of broadcast seeders with the most common being the "cyclone" type which may be electrically, hydraulically or PTO-driven. Other ways to broadcast seed include the dribble seeder, air applicators and aerial seeding.

After the seed has been broadcast, it must be covered lightly with soil. This is done with a float made of chain, cable, car tires or any other object that will move only enough soil to bury the seed. Land rollers or packers will also help to bury the seed.

4.6 Land Rolling

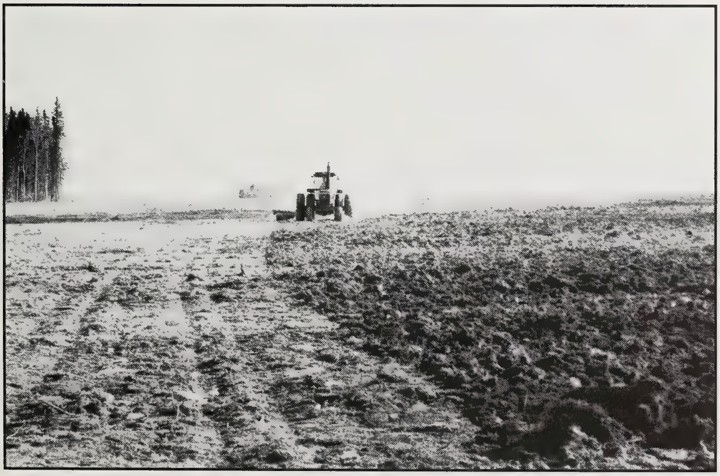

FIGURE 22. *Land rolling. Rolled land on left contrasts with rough land on right*

Land rolling is often one of the last steps in seed-bed preparation on new land. Rollers are simple, pull-type implements that range in size from large, single cylinders 4 ft. (1.2 m) in diameter by 20 ft. (6 m) long, to smaller versions 2 ft. (.6 m) in diameter by 6 ft. (2 m) long. The smaller rollers are often hooked in tandem or trio to increase total swath width. Most rollers are hollow metal cylinders that may be filled with water for extra weight; however, some of the smaller rollers may be solid cement. A drawbar is attached to the cylinder ends, and the roller is ground-driven as it is pulled by the tractor. Weights vary widely, but large rollers can weigh up to 6 - 7 tons (5.5 - 6.5 tonnes) empty and 13 - 14 tons (12 - 13 tonnes) when full. The tractor size required depends on land contour. Two-wheel-drive farm tractors of 100 hp or less will pull most rollers on level ground, but larger 4-wheel-drive tractors may be needed for big rollers in hilly terrain where traction or stability is a factor.

Land rollers are designed to pack and level land. Long models work best on level to gently rolling fields, whereas shorter rollers are better suited to follow abrupt topography changes. They are ideally suited to new land that is soft and fluffy from primary tillage and/or has small woody trash or rocks remaining unpicked. The rollers will imbed rocks and roots and firm the seedbed. They leave the field surface smooth and firm for other ground operations such as spraying, swathing, haying, combining, etc., and promote the rotting of woody trash which has been buried.

There are also "Brillion" type packers which are used to help level land and prepare seedbed. They consist of a single gang of large (18 in./46 cm) narrow (1.5 in./4 cm) cast iron wheels which are individually suspended on a shaft. Their suspension allows individual wheels to follow land contours or go over trash. Unlike rollers which leave a very smooth packed seedbed, these packers leave small holes and ridges which are ideal microsites for seed germination.

Firming the seedbed brings moisture to the surface and promotes germination. Some rollers have broadcast seed attachments mounted on the drawbar which allow seeding and rolling in one operation. This is very useful on trashy land where drills and harrows can be damaged or plugged. In soft soil, the roller will cover the seed adequately so harrowing is not required. Very large rocks can damage the cylinder and under some conditions, soil pulverization could be a problem when land is rolled. Land rolling is generally a quick and inexpensive treatment since most rollers can cover from 7 - 14 ac. (3 - 6 ha) per hour, depending on conditions.

BIBLIOGRAPHY

Alberta Agriculture, Farm Business Management Branch. 1981. Land Clearing and Breaking Equipment Costs. Edmonton. (Agdex 825-8)

Alberta Agriculture, Agricultural Engineering Branch. September 1985. Build Your Own Land Roller with Transport Wheels. Edmonton.

Crofts, A.K. 1981. Energy Fuels Corporation. Methods of Mechanical Plant Control at the Energy Fuels Mine in Northwest Colorado. Steamboat Springs, Colorado.

Dika Construction Co. Ltd. No date. Dika Root Windrower Series 100. Rycroft, Alberta.

Dika Construction Co. Ltd. No date. Dika Wheel Type Root Rake. Rycroft, Alberta.

Ehlert, Gerry. 1983. Range Improvement Project Evaluation (RIPE) Observations 1983. Alberta Energy & Natural Resources, Range Management Section. Edmonton. Agdex 748-1.

Fleco Corporation. No Date. Land Clearing Techniques and Equipment: V-Tree Cutters. Jacksonville, Florida. (Booklet 3)

Government of the Province of Alberta. The Forest and Prairie Protection Act Regulations, Parts 1 and 11. Edmonton. (Office Consolidations)

J.H. Beales Steel Fabricators Ltd. No Date. Auxillary Equipment Catalogue. Langley, British Columbia.

Kepner, R.A., R. Bainer and E.L. Barger. 1978. Principles of Farm Machinery. 3rd Edition. AVI Publishing Company, Inc. Westport, Connecticut.

Manitoba. Department of Agriculture. 1975. Discers. Publication 469 Winnipeg, Manitoba.

Pieche, K.W. and Campbell, P.W.E. 1965. British Columbia Forest Service, Engineering Service Division. Ball and Chain Assembly for Downing Forest Stands. (File 0204783)

Prairie Agricultural Machinery Institute. February, 1982. Rock Handling. Implement Quarterly. Supplement to Farm Light and Power. (200M - Jan 82-Midwest.)

Rome Plow Division. No date. Harrow Selection Guide. Cedartown, Georgia. (MBG-505B (5-81))

Rome Plow Division. No date. K/G Clearing Blades, Series KGA, KGBA, KGB Cedartown, Georgia. (Form ILS 197A (4-78))

Rotoclear Mfg. Ltd. No date. Madge Rotoclear Specification Sheet. Calgary, Alberta.

Shur-way Implements. No date. Shur-way Rootrakes. Grande Prairie, Alberta.

Towner Manufacturing Company. Specification sheets for wheel and draw type offset disc harrows. Santa Anna, California. (750-76, 760-77, 850-76, 650-70Y, 700-76, 800-76)

U.S. Department of Agriculture, Forest Service Equipment Development Center. 1971. Tractor Attachments for Brush, Slash, and Root Removal. San Dimas, California. (ED & T 1332)

U.S. Department of Agriculture, Forest Service Equipment Development Center. 1970. Results of Field Trials of the Tree Eater, a Tree and Brush Masticator. San Dimas, California. (ED &T 1222)

U.S. Department of Agriculture, Forest Service Equipment Development Center. 1982. History of the Vegetative Rehabilitation and Equipment Workshop (VREW) 1946 - 1981. Missoula, Montana. (2200 - Range. 8222 2805).

U.S. Department of Agriculture and Department of the Interior, Forest Service Equipment Development Center. 1983. Vegetative Rehabilitation and Equipment Workshop, 37th Annual Report, Albuquerque, New Mexico. Missoula, Montana. (2200 - Range 8322 2804)

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